

Overcoming Power-cuts: UNINTERRUPTED DC POWER FOR HOMES

De-centralized Solar PV Applications

PROJECT PV-5: Reliability and Applications

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The Current dismal power situation in India

The Power Crisis has Lead to

- Frequent and prolonged power outages
- Outages which last between 2-20 hours a day
- Inverters being rendered futile as there is a lack of sufficient power to charge them
- DG and diesel costs too high
- Inability to use essentials like lights and fans
- Inadequate power supply for charging laptops, mobiles and tablets
- Inutility of sources of entertainment like television and radio as well

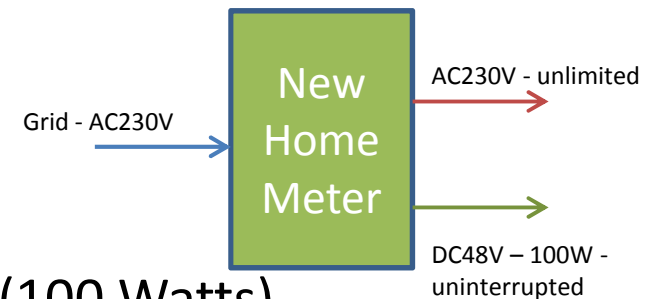
Solar PV Solution to Loads of Four Sectors

- Residential
- Commercial (Offices)
- Rural
- Industry

RESIDENTIAL

Innovative Scheme

In additional to the current line, EB will provide an additional line



- This line will carry a small amount of power (100 Watts)
 - But will be **uninterrupted 24 x 7 – will have no power-cuts**
 - Plus cost will be low -- say Rs 4 per unit for the additional line
 - Can be used to provide lights / fans/ electronics and even LED / LCD TV
 - May not support refrigerator, air-conditioners, air-cooler, mixie, grinder, hair-drier
 - But is 100 Watts enough? We think so, just wait to find out what you can do
- Additional line will be 48V DC supply
 - Will need separate wiring
 - And devices which use DC supply

The DC based Powering System

- Can power today (can be installed incrementally)
 - 2-3 LED lights
 - Rs 200 to 500 each
 - 2W to 15W (equivalent to 4W to 30W tube-lights)
 - 2 DC fans
 - 30W each (equivalent to 70W AC fan)
 - Rs 2200 each
 - Mobile/laptop/tablet charging
 - Require new chargers
 - Far more energy efficient (few watts to 50 W)
 - LCD / LED TV with DC input
 - 22inches TV consumption about 40W

100W will enable three lights + 2 fans + cell-phone charging

• or with a small TV (22" LED/LCD) and one fan

- Tomorrow
 - DC powered energy-efficient refrigerators
 - DC air-conditioners?



But 100W could pose limitation tomorrow

- One can enhance DC power
 - With incremental modular investments of as little as Rs 5000
 - Add solar panels and batteries to the augment existing uninterrupted DC power Supply
 - At Rs 15000 investment, one may enhance DC line to 225W most of the time
 - Add more fans / lights / plug-points / refrigerators
- Of course AC power can continue to be used with existing devices
 - But with power-cuts



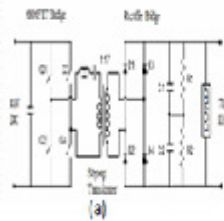
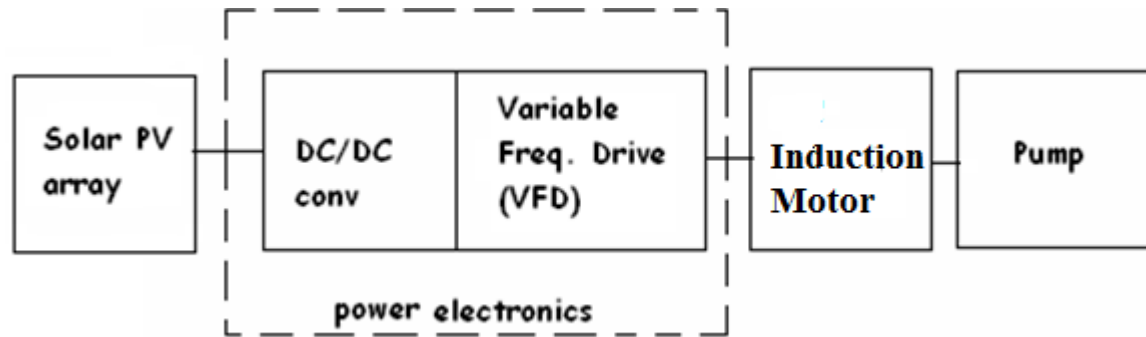
COMMERCIAL

Air cons/LEDS/Fans

- **Major Loads: Air Conditioners , LEDs and Fans**
- **Natural Supply Demand Match**
- **Use solar DC power directly to drive**
 - **Air-conditioner with BLDC motors based compressor**
 - **Use smart Controller for Load and supply match**

RURAL

Solar PV Water Pumps



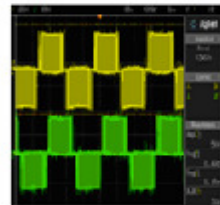
(b)



(c)



(d)



(e)



1 Hp, 48 V Solar PV

Publications

- **Communicated to 2013 PVSC Conference held at Florida, Tampa.**
 - *Solar Powered DC Commercial Buildings*, Ashok Jhunjunwala, Lakshminarasamma and Krishna Vasudevan.
 - *Analysis of Subsystems and Performance Evaluation of Solar Photovoltaic Powered Water Pumping System*, Sadasivam P, M.Kumaravel, Krishna Vasudevan and Ashok Jhunjunwala.

Thanks

SYSTEM ASPECTS

Uninterrupted DC (UDC) Power System

- Utilities Grid
 - No change in central power distribution system
 - Wiring, transformers
 - Yet provide to home a limited amount of uninterrupted DC power supply
- UDC Meter at home will provide
 - Unlimited 230V AC supply whenever it is available; this supply will be cut during *brown outs**
 - Limited 48V DC supply (100 WATTS) which will be uninterrupted; this will not be cut during the *brown outs*
 - Solar panel interface to augment the DC supply; with facility for modular addition of solar panels

* There will be no black-outs after this; instead brown-out state implies that existing AC devices will be off, but DC devices will work upto 100W

CONTINUED...

- At the central power distribution level
 - Use of a 3:1 transformer to feed at 33KV substations during the brownouts
 - This would result in voltage being reduced to a fraction (one-third) at customer's premises rendering the existing AC devices inoperable during the brown outs; DC power limited to 100W
- DC appliances which can be powered at 48V DC
 - LEDs and DC fans; both of which can be controlled using a remote control
 - Electronics which includes charging of laptops, tablets and mobile phones
 - LCD/LED television with a set-top box
 - Potential to add a small refrigerator

CONTINUED...

- Devices which work on **DC consume less power** and are **more energy-efficient**

DEVICE	POWER CONSUMED
LEDs	2W-15W
DC Fans	30W at full speed
Mobile Charging	5W
Tablet Charging	5W-15W
Laptop Charging	65W
LCD/LED TV	40W for 22 inches

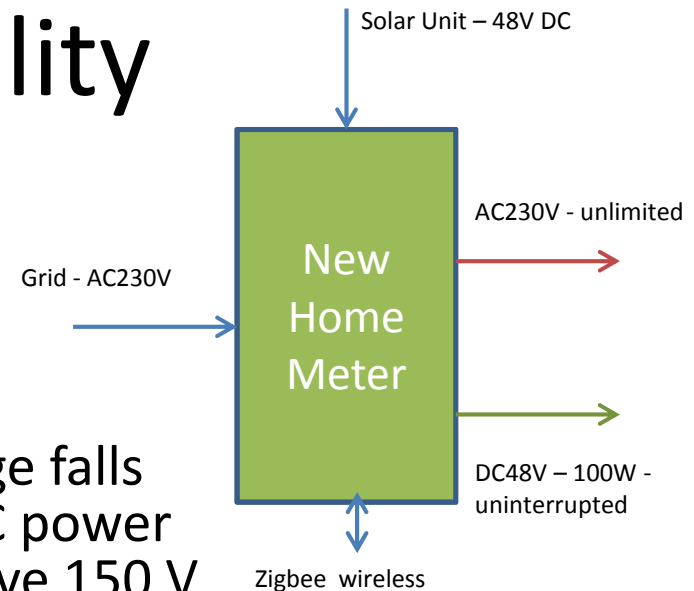
- The facility to have incremental addition of solar panels to the UDC meter **solves** the **power crisis**, provides a **boost for DC devices** and also **encourages** a **shift** towards **decentralized power production** using **photo-voltaics**

UDC METER: TOP LEVEL TECH SPECS

UDC meter functionality

- AC Part of the UDC meter

- Meters AC power with time of day
- Has relays to cut off AC power
- Monitors input voltage, if the voltage falls below 100V, AC power is cut-off; AC power is restored when the level goes above 150 V



- DC Part of the UDC :

- An AC-DC Converter gives 48 V DC at 100W (uninterrupted)
- When the consumption goes above 100W, a buzzer warning would sound for a minute and then cut off the power
- It entails manual switching on to restore the power
- Meters DC with time of day metering

Solar Unit Input

- Modular addition of Solar unit
 - solar panel supplements 48V DC power for consumption above 100W
 - Solar charges the battery when the load is below 100W
 - If battery is fully charged, solar power used first for DC load
 - Battery power supplements 100W DC when needed

Zigbee Wireless Interface

- Used to transfer metering data, monitor usage and for software updates
 - Can enable limiting of DC power per home to say 1.5 kWh a day
 - Helps in monitoring the solar power generated
- Provides an adhoc network of neighboring meters
 - Remote management via a Zigbee – GPRS uplink unit in vicinity for multiple meters